Zero Gravity Testing of a Microgravity Rock Coring Drill using Microspines

Microgravity Drilling

Drilling in microgravity is challenging – there is no mature way to preload the drill bit and resist the toque

Our technology anchors to the rock and redirects the weight on bit and drilling torques back into the rock

Lab testing requires offloading the weight of the drill; Testing on a parabolic aircraft will allow full 6DOF zero-g validation and provide useful data for future development

Potential users include

Asteroid Redirect Robotic Mission
Asteroid Redirect Crewed Mission
Mars Lava Tube Mission

Technology Development Team

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Future collaborators include:

NASA Johnson Space Center (Crew Systems Office)

NASA Langley Research Center

NASA Goddard Space Flight Center (Asteroid Retrieval Mission)

Proposed Flight Experiment

Experiment Readiness:

- The experimental apparatus is assembled and can be ready for flight within 2 weeks notice.

Test Vehicles:

- Parabolic Aircraft.

Test Environment:

- Request zero-g environment.

Test Apparatus:

- A stewart platform supports our anchor and drill, providing free 6DOF motion. The platform can be frozen in place between parabolas using pneumatic brakes.
- Swappable rock tiles are mounted to a 6 axis force/torque sensor for anchor strength testing and drilling demonstrations.
- Free floating rock capture can also be performed using tethered rocks
- An aluminum cage with polycarbonate sides encloses the experiment to prevent particulates and dust from entering the cabin

drilling inverted with microgravity anchor/drill

Technology Maturation

Current TRL: 4

TRL 5:

- test in relevant environ. (zero-g)
- mid-fidelity prototype w/ flight-like components

TRL6:

- high-fidelity prototype w/ flight electronics, actuators, materials, margins
- test in full range of expected operating conditions (temp, rad, vac)
- high fidelity models of performance

Objectives of Experiment

1. In a floating environment, demonstrate the ability to anchor to a high-inertia asteroid (>2 meter diameter)
2. In a floating environment, demonstrate the ability to acquire a core sample from a high-inertia asteroid (>2 meter diameter).
3. In a floating environment, demonstrate the ability to grapple a low-inertia rock sample (<30cm diameter)

Flight data includes anchor strength, misalignment angles, and drilling rates/loads which can inform the next design iteration of the tool.

4.3.6 Robotic Drilling and Sample Processing 4.2 Robotic Mobility
7.3 Advanced Human Mobility Systems (anchoring, translation, and worksite stabilization)

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